JHR 97: 881–893 (2024)
doi: 10.3897/jhr.97.134513
https://jhr.pensoft.net

RESEARCH ARTICLE

JOURNAL OF Hymenoptera RESEARCH
A peer-reviewed open-access journal
The International Society of Hymenopterists

An update on the wild bee fauna (Hymenoptera, Apoidea, Anthophila) of Serbia

Sonja Mudri-Stojnić[1], Andrijana Andrić[2], Laura Likov[1], Ana Grković[1], Tamara Tot[1], Ivana Kavgić[1], Ante Vujić[1]

1 *Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Department of Biology and Ecology, Trg Dositeja Obradovića 2, 21000 Novi Sad, Serbia* **2** *BioSense Institute, University of Novi Sad, Dr Zorana Đinđića 1, 21000 Novi Sad, Serbia*

Corresponding author: Sonja Mudri-Stojnić (sonja.mudri-stojnic@dbe.uns.ac.rs)

Academic editor: Christopher K. Starr | Received 12 August 2024 | Accepted 17 September 2024 | Published 15 October 2024

https://zoobank.org/136F6129-8247-4DD0-9131-90A6DC063503

Citation: Mudri-Stojnić S, Andrić A, Likov L, Grković A, Tot T, Kavgić I, Vujić A (2024) An update on the wild bee fauna (Hymenoptera, Apoidea, Anthophila) of Serbia. Journal of Hymenoptera Research 97: 881–893. https://doi.org/10.3897/jhr.97.134513

Abstract

Numerous wild bee (Hymenoptera, Apoidea, Anthophila) species show negative population trends, while the knowledge gaps on their occurrences and distributions prevent adequate conservation actions. The need for continuous updating of species records and reconfirmation of their presence has been recognized, especially in understudied areas. The present study presents the results of bee monitoring at 30 Serbian localities, each surveyed three times during 2023. Two sampling methods were used, the transect walks and the pan traps, resulting in a detection of 232 wild bee species. Among them, 13 species found at 13 localities, represent the first published records from Serbia: *Andrena ferox* Smith, 1847, *A. nana* (Kirby, 1802), *A. praecox* (Scopoli, 1763), *A. pusilla* Pérez, 1903, *A. susterai* Alfken, 1914, *A. angustior* (Kirby,1802), *A. curvungula* Thomson,1870, *A. falsifica* Perkins, 1915, *Hoplitis mitis* (Nylander, 1852), *Hylaeus friesei* (Alfken, 1904), *Melitta melanura* (Nylander, 1852), *Nomada trapeziformis* Schmiedeknecht, 1882, and *Osmia uncinata* Gerstaecker, 1869. This study contributes to an update of the list of bee species in Serbia, that now counts 744 species, and also provides additional data on European distributions. The new information on *Melitta melanura* is especially noteworthy, since this species has been assessed as Endangered by the European Red List of Bees due to its small area of occupancy and a severely fragmented distribution. Other important findings include the confirmation of the presence of some wild bee species in Serbia, i.e., 10 species reported as new records within the previous update, and 19 species that were without previously available records from the 21st century. Additionally, the present study indicates the effectiveness of both conducted monitoring techniques, in terms of different recorded species and numbers of specimens. These results lead to the conclusion that corroborates the application of complementary sampling methods as an adequate way to survey bee diversity and abundance.

Copyright *Sonja Mudri-Stojnić et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Keywords
Diversity, *Melitta melanura*, monitoring, new records, sampling methods, wild bee species

Introduction

The crucial role of bees (Hymenoptera, Apoidea, Anthophila), as the most important pollinator group in ecosystems worldwide, is unquestionable nowadays. At the same time, many wild bees show negative population trends, while the knowledge on their spatial distribution is incomplete, with data gaps preventing adequate conservation actions in Europe (Nieto et al. 2014; Potts et al. 2021). Thus, an effort has recently been made to update the information on present species, including their occurrences (Ghisbain et al. 2023; Reverté et al. 2023). However, this is an ongoing issue, especially in the data deficient areas such as Southeastern Europe (Potts et al. 2021), where several scientific projects are being implemented in terms of the systematic monitoring and the gathering of information on bees and other wild pollinating insects, e.g., in Serbia (Mudri-Stojnić et al. 2023).

Serbia is situated at the crossroads of Southeast and Central Europe, within the central Balkan Peninsula and the southern Pannonian Plain. Such a geographical position leads to a mixture of elements of various habitat types, i.e., Pannonian, continental, sub-Mediterranean and mountain. Agricultural landscapes occupy the majority of its territory (63.7%), while protected areas cover 7.6%, and the ecological network of nationally and internationally significant areas cover 21% of the total area of Serbia (Spatial Plan RS 2021–2035 in Official Gazette RS 2020). The diversity of habitat types and the presence of quite well-preserved habitats have affected the relatively high diversity of wild bees. Namely, according to the latest data, Serbia hosts as many as 731 bee species (Mudri-Stojnić et al. 2021, 2023). The neighboring countries, with somewhat similar habitat types, have comparable numbers, i.e., 704 bee species in Hungary (Józan 2011), and 760 in Romania (Tomozii 2010). A number of rich ecosystems, with high species diversity of numerous groups of organisms, has led to enacting several national laws and by-laws regulating the field of nature conservation in Serbia, including the "Rulebook on declaration and protection of strictly protected and protected wild species of plants, animals and fungi" (Official Gazette RS 2016). According to this Rulebook (Appendix 2), the only species of the superfamily Apoidea listed as protected at the national level is *Bombus confusus* Schenck, 1861. However, there are a number of bee species recorded in Serbia which are of conservation concern at the European level (Mudri-Stojnić et al. 2021, 2023). Namely, according to the current European Red List (Nieto et al. 2014), one species (*Bombus cullumanus* Kirby, 1802) is listed as Critically Endangered, 18 as Endangered, 10 as Vulnerable, and 64 as Near Threatened. Nevertheless, almost one third of bee species known in Serbia are classified as Data Deficient in Europe, while many of the listed species have not been recently recorded in Serbia.

Therefore, the need for reconfirmation of the current presence and re-evaluation of the conservation status of species has been noted, especially since there is still no national Red List of bees for Serbia. In recent years, steps have been taken in that direction, firstly

by summarizing the available data and preparing the preliminary list of species (Mudri-Stojnić et al. 2021), and then by conducting additional surveys in order to confirm and update this list (Mudri-Stojnić et al. 2023). An important contribution to obtaining the data regarding the status of bees, and other key groups of wild insect pollinators in Serbia, is the recent establishment of the scientific project "Serbian Pollinator Advice Strategy - for the next normal" (SPAS 2022–2024), as a preparatory phase for the EU Pollinator Monitoring Scheme (EU-PoMS, Potts et al. 2021). The goal of the SPAS project is to build a long-term national monitoring strategy compatible with the European one.

Considering that the updating of species records is a continuous issue, the main aim of the present study is to proceed to amend the information on wild bees occurring in Serbia. Thus, the specific goals are: (1) to present the first published records from Serbia for 13 species; (2) to confirm the presence of 19 species for which 21st century records have been lacking; and (3) to confirm the presence of 10 species reported as new records during the previous update of Serbian bee fauna.

Materials and methods

The data for the present study were obtained within the implementation of the national scientific project SPAS (2022–2024). The project encompasses monitoring insect pollinators at 30 localities across Serbia (Fig. 1), including various habitat types: forest steppe, forest meadow, mountain meadow, wet meadow, sub-Mediterranean grassland, rocky grassland, and steppe grassland. The information introduced in the present study was gathered during 2023. The surveys were conducted on three occasions per locality, from the end of March to September, a period which coincides with the blooming of most flowering plant species in Serbia.

Specimens of wild bees were collected using two methods, following the protocol applied within the SPAS project (Mudri-Stojnić et al. 2023). Transect walks included a collection with a sweep net, lasting ~ 30 min per site, and covering ~ 500 m length and 2 m width. Placed along each transect was a set of ten pan trap stations, with three colored bowls per group (white, yellow and blue), filled with water and some soap. The species were identified in the laboratory of the Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Serbia (**FSUNS**), and by expert Józan Zsolt (Mernye, Hungary).

The list of previously unpublished records for bee species in Serbia is provided in full, whereas the list of all recorded species can be found in Suppl. material 1, with additional information provided for each species: IUCN (The International Union for Conservation of Nature) categories (Nieto et al. 2014), collection methodology types, data on species with previous records based solely on literature data. Detailed information on collected specimens (i.e., locality, date, sex, identification code, collection methodology type, legator) has been provided within Suppl. material 2 for species with occurrences previously available only from sources prior to the year 2000, and within Suppl. material 3 for species reported as new records during the previous update of Serbian bee fauna (Mudri-Stojnić et al. 2023).

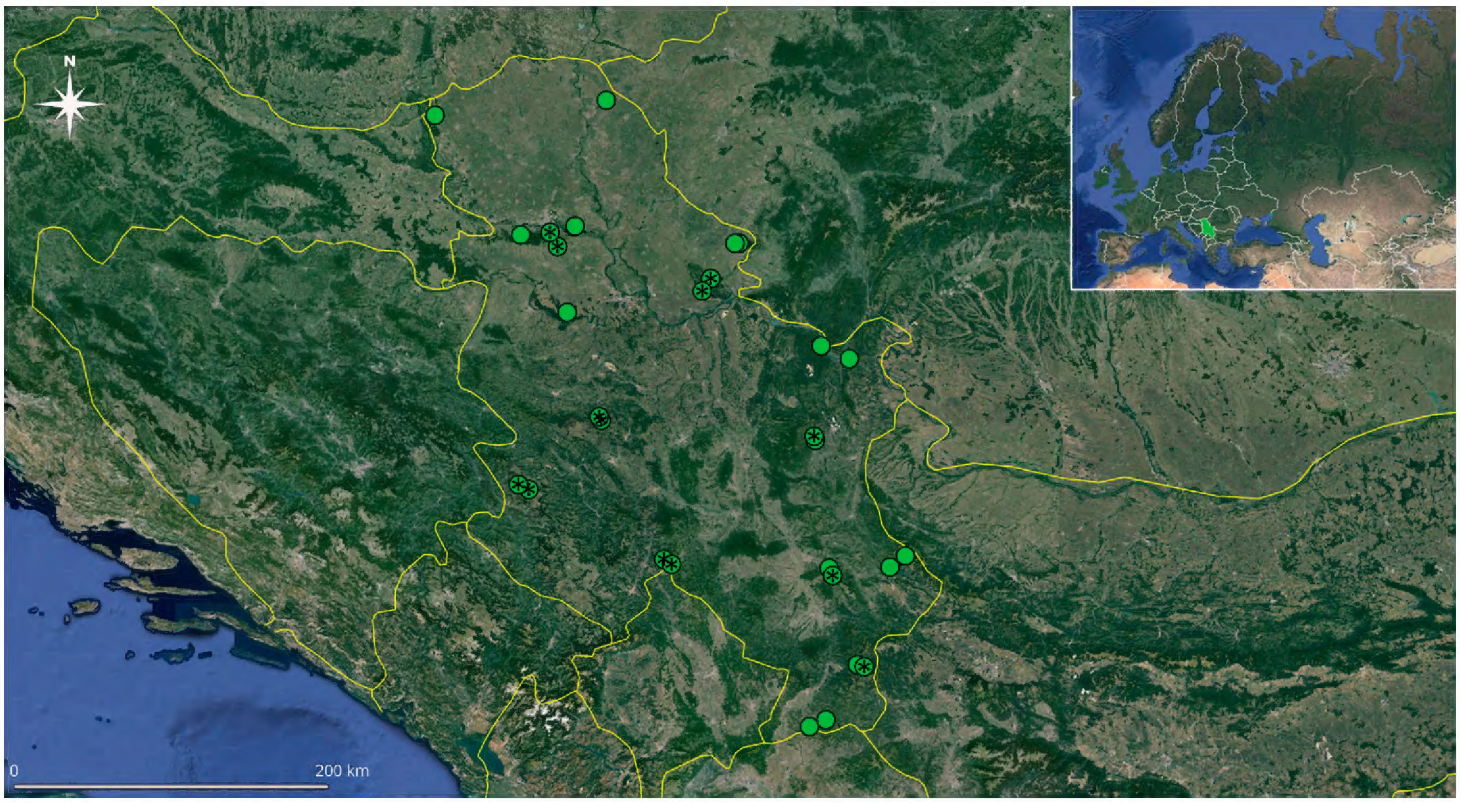

Figure 1. Map of Serbia showing collection localities. Stars indicate localities where new species records were detected.

Results

During the survey of all 30 localities conducted throughout the 2023 season, 2,950 specimens from 232 bee species were recorded (Suppl. material 1). The method of transect walks resulted in the detection of 92 species, 55 species were caught in pan traps and 85 species were found using both methods. With respect to the so far published information (Mudri-Stojnić et al. 2021, 2023), 13 species recorded in the present study have not been previously recorded in Serbia. These 13 species were detected at 13 localities (Fig. 1), eight species (16 specimens) during transect walks (*Andrena angustior* (Kirby,1802), *A. ferox* Smith, 1847, *A. nana* (Kirby, 1802), *A. susterai* Alfken, 1914, *Nomada trapeziformis* Schmiedeknecht, 1882, *Hylaeus friesei* (Alfken, 1904), *Osmia uncinata* Gerstaecker, 1869, and *Melitta melanura* (Nylander, 1852)), and four species (six specimens) were found in pan traps (*Andrena curvungula* Thomson, 1870, *A. praecox* (Scopoli, 1763), *A. pusilla* Pérez, 1903, and *Hoplitis mitis* (Nylander, 1852)), while only one species (*Andrena falsifica* Perkins, 1915) was recorded using both collection methods (five specimens with sweep net and two specimens in pan traps). According to the IUCN Red List Categories (Europe) (Nieto et al. 2014), these 13 species have been accessed as: EN - Endangered (one species, i.e., *Melitta melanura*), NT - Near Threatened (two species), LC - Least Concern (four species), and DD - Data Deficient (six species).

Nineteen bee species recorded in the present study (46 specimens, see Suppl. material 2) were without confirmed records from the 21st century, i.e., they were known to be present in Serbia only according to older literature data, some of them dating ~ 100 years back, i.e.: *Nomada striata* Fabricius, 1793 (Apfelbeck 1896), *Protosmia longiceps* Friese, 1899 (Vorgin 1918), *Andrena denticulata* (Kirby, 1802), *A. ventralis* Imhoff,

1832, and *Eucera dalmatica* Lepeletier, 1841 (Lebedev 1931). According to sampling methodologies, out of these 19 species, 10 species (33 specimens) were detected only by the use of pan traps, eight species (10 specimens) were recorded solely on transect walks, and one species (*Andrena combinata* (Christ, 1791)) was found by both methods (two specimens with sweep net and one specimen in pan trap).

Another noteworthy finding of the present study is the recording of 10 bee species (out of 25) introduced by Mudri-Stojnić et al. (2023) as new records for Serbia (Suppl. material 3). Thus, their presence has now been confirmed and furthermore, eight of these species have been found at different localities than previously, i.e., four solely at new localities and four at both new and some previously recorded localities. One of the 10 species was detected using a different method than previously, six using the same method, and three species found using both sampling methods in the 2022 survey were recorded by only one of the methods in the 2023 survey (see Suppl. material 1). Out of the 232 bee species recorded in the present study (survey of 2023), 180 species were also recorded during the previous survey (2022) (Mudri-Stojnić et al. 2023). The majority, i.e., 109 species were detected using the same sampling method in both years, 16 species were found by different methods, and 55 species were recorded using one method during one year and both methods during the second year (see Suppl. material 1).

New records of wild bee species in Serbia

Family Andrenidae

Andrena Fabricius, 1775

Andrena angustior (Kirby, 1802) [DD]

- 1 ♀; Suva planina, Bojanine vode; 43.2260°N, 22.1068°E; 23 Apr. 2023; Laura Likov leg.; FSUNS SPAS10842.

Andrena curvungula Thomson, 1870 [DD]

- 1 ♀; Fruška gora, Glavica; 45.1851°N, 19.8562°E; 12 Jun. 2023; white pan trap; FSUNS SPAS31681.

Andrena falsifica Perkins, 1915 [DD]

- 1 ♀; Kopaonik, Kadijevac; 43.3203°N, 20.7621°E; 20 May 2023; yellow pan trap; FSUNS SPAS31396 • 1 ♀; Vlasina, mahala Damnjaničovi; 42.6947°N, 22.3580°E; 24 May 2023; yellow pan trap; FSUNS SPAS11175 • 1 ♀; Deliblato Sands, Čardak; 44.8626°N, 21.0569°E; 23 Apr. 2023; Sonja Mudri-Stojnić leg.; FSUNS SPAS01610 • 3 ♀♀; Zlatibor, Obudovica; 43.7227°N, 19.6881°E; 17 May 2023; Ana Grković leg.; FSUNS SPAS31164, SPAS31175, SPAS31176 • 1 ♀; Zlatibor, Semegnjevo; 43.7514°N, 19.6037°E; 14 Jun. 2023; Ana Grković leg.; FSUNS SPAS31432.

Andrena ferox **Smith, 1847 [DD]**

• 1 ♂; Deliblato Sands, Šušara; 44.9261°N, 21.1353°E; 23 Apr. 2023; Sonja Mudri-Stojnić leg.; FSUNS SPAS01582.

Andrena nana **(Kirby, 1802) [LC]**

• 1 ♂; Zlatibor, Obudovica; 43.7227°N, 19.6881°E; 17 May 2023; Ana Grković leg.; FSUNS SPAS31172.

Andrena praecox **(Scopoli, 1763) [LC]**

• 1 ♀; Fruška gora, Neradin; 45.1061°N, 19.9156°E; 30 Mar. 2023; yellow pan trap; FSUNS SPAS01169 • 2 ♀♀; Vlasina, mahala Damnjaničovi; 42.6947°N, 22.3580°E; 24 May 2023; yellow pan trap; FSUNS SPAS11173; white pan trap; FSUNS SPAS11177.

Andrena pusilla **Pérez, 1903 [DD]**

• 1 ♀; Fruška gora, Neradin; 45.1061°N, 19.9156°E; 30 Mar. 2023; blue pan trap; FSUNS SPAS01452.

Andrena susterai **Alfken, 1914 [DD]**

• 2 ♀♀; Rajac, Gornji Banjani; 44.1200°N, 20.2643°E; 16 May 2023; Ana Grković leg.; FSUNS SPAS 31129; FSUNS SPAS31130 • 1 ♀; Rajac, Slavkovica; 44.1404°N, 20.2471°E; 16 May 2023; Ana Grković leg.; FSUNS SPAS31071.

Family Apidae

Nomada **Scopoli, 1770**

Nomada trapeziformis Schmiedeknecht, 1882 [NT]

• 2 ♀♀; Vlasina, mahala Damnjaničovi; 42.6947°N, 22.3580°E; 24 May 2023; Laura Likov leg.; FSUNS SPAS11132, SPAS11133.

Family Colletidae

Hylaeus **Fabricius, 1793**

Hylaeus friesei **(Alfken, 1904) [NT]**

• 1 ♀; Lazar's canyon, Lazar's cave; 44.0286°N, 21.9587°E; 9 Jun. 2023; Tamara Tot leg.; FSUNS SPAS20912.

Family Megachilidae

***Hoplitis* Klug, 1807**

***Hoplitis mitis* (Nylander, 1852)**

• 1 ♂; Kopaonik, Mali Karaman; 43.2910°N, 20.8235°E; 23 Jun. 2023; blue pan trap; FSUNS SPAS31655.

Osmia Panzer, 1806

***Osmia uncinata* Gerstaecker, 1869 [LC]**
• 1 ♀; Kopaonik, Kadijavac; 43.3203°N, 20.7621°E; 23 Jun. 2023; Ana Grković leg.; FSUNS SPAS31641.

Family Melittidae

***Melitta* Kirby, 1802**

Melitta melanura (Nylander, 1852) [EN]

• 4 ♀♀; Deliblato Sands, Šušara; 44.9261°N, 21.1353°E; 29 Aug. 2023; Ante Vujić leg.; FSUNS SPAS02277, SPAS02282, SPAS02283, SPAS02284 • 2 ♂♂; Deliblato Sands, Šušara; 44.9261°N, 21.1353°E; 29 Aug. 2023; Ante Vujić leg.; FSUNS SPAS02287, SPAS02279.

Discussion

The present study has resulted in the introduction of 13 wild bee species (from five different families) previously unrecorded in Serbia. Most of them belong to the family Andrenidae with eight species from the genus *Andrena*. They are followed by Megachilidae (one *Hoplitis* and one *Osmia* species) and one species each from Apidae (*Nomada*), Colletidae (*Hylaeus*), and Melittidae (*Melitta*). The previous update of Serbian wild bee fauna (Mudri-Stojnić et al. 2023) also presented the majority (10 out of 25 newly-recorded) species from the genus *Andrena*, and the recently published preliminary list of bee species in Serbia (Mudri-Stojnić et al. 2021) mentions *Andrena* as the genus most rich in species. According to the results of the present study, *Andrena* remains as the genus with the highest number of species in Serbia, namely 122. Considering all recorded species, including the newly-presented records, the bee fauna of Serbia numbers 744 species.

One of the valuable findings of the present study is the detection of six specimens of *Melitta melanura*, a species assessed as Endangered according to the latest European regional assessment (Michez and Nieto 2012). Up to date, it has not been recorded in

Serbia (Mudri-Stojnić et al. 2021, 2023). However, there are records from the neighboring countries (Reverté et al. 2023), i.e., Romania (Tomozii 2010) and Hungary (as synonym *Melitta wankowiczi* (Radoszkowski, 1891)) (Józan 2011). Although widely distributed in Palaearctic, from Siberia to Austria to Turkey (Michez and Eardley 2007; Michez and Nieto 2012; Özbek 2014), the species records are rare and the populations are isolated, and it has been assessed as Endangered due to its small area of occupancy and a severely fragmented distribution (Michez and Nieto 2012). Therefore, the new information could represent a valuable asset to the knowledge on the presence of this species in areas where it has not been previously recorded. Although considered threatened at national levels in some countries, no direct conservation measures are in place; however, it has been suggested that natural reserves should be created to protect the host-plants in locations of isolated populations of *M. melanura* (Radchenko 2009; Michez and Nieto 2012). These oligolectic bees live in temperate grassland vegetation with Campanulaceae, mostly *Campanula* sp. as host-plants (Michez and Eardley 2007; Michez et al. 2008). The locality where *M. melanura* was found in the present study is situated within the Deliblato Sands Special Nature Reserve, whose diverse flora includes ten species of *Campanula* L. (Ćuk 2019).

With respect to the two applied collection methodologies, most of the species recorded in the present study (40%) were detected only during transect walks, 24% of species were caught only in pan traps, and 36% were found using both methods. The similar pattern was found by Mudri-Stojnić et al. (2023) with 41%, 27%, and 32% of the total number of found species, respectively. Regarding the 13 new species records for Serbia, 61% were detected only during transect walks, 31% only in pan traps, and 8% by both methods, while these percentages for the number of specimens were 57%, 21.5%, and 21.5%, respectively. Regarding the 19 species previously known only from old literature, this ratio was 42%, 53%, and 5% for the number of species, and 22%, 72%, and 6% for the number of specimens. Taking into account all these percentages, a conclusion imposes itself that the use of both collection methods is the best way to assess bee diversity and abundance, since many species were detected by only one of the used sampling techniques, with the number of specimens between them varying. Furthermore, it may be noted that for some species the method used to sample them was not the same during both survey years. Comparing the results of the present survey with the previous one (Mudri-Stojnić et al. 2023), 61% of species recorded in both surveys were found using the same sampling method, 9% were detected by a different method, and 30% of species were recorded using one method during one year and both methods during the second year. Both the transect walks, designed to survey flying insects, and the pan traps, intended for nectar-searching insects, have been recognized as methods suitable for the monitoring of bees. However, both approaches have some limitations and a combination has been suggested as the most effective (Nielsen et al. 2011; Potts et al. 2021; Leclercq et al. 2022). The validity of transect walks depends on the experience of collectors (Nielsen et al. 2011), whereas pan traps provide data without observer bias, but they are not always representative of the local community and their effectiveness might be influenced by the surrounding floral resources (Cane et al. 2000; Roulston et al. 2007; Westphal et al. 2008). Furthermore, there is a need for further research in terms of standardization,

and a regular review of sampling designs for future long-term bee monitoring programs (Krahner et al. 2024). The conservation management efforts and decisions depend on the understanding of bees' ecological communities, and are thus influenced by the choice of sampling methods (Kuhlman et al. 2021), thus determining the most suitable monitoring techniques is a prerequisite for assessing the status and trends of bee populations.

Acknowledgements

We are especially grateful to Zsolt Józan for assistance in species identification. Thanks also to to Igor Ivkov for his English proofreading. We also thank the reviewer Sara Reverté. The data for this study were obtained as part of the implementation of project SPAS - Serbian Pollinator Advice Strategy - for the next normal (Science Fund of the Republic of Serbia, Program IDEAS, GA ID: 7737504). The authors also acknowledge the financial support of the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Grants No. 451-03-66/2024-03/200125 and 451-03-65/2024-03/200125, and Grant No. 451-03-66/2024-03/200358).

References

Apfelbeck V (1896) Balkanske Apide (pčele). Glasnik zemaljskog muzeja u Bosni i Hercegovini 8: 329–342.

Cane JH, Minckley RL, Kervin LJ (2000) Sampling bees (Hymenoptera: Apiformes) for pollinator community studies: pitfalls of pan-trapping. Journal of the Kansas Entomological Society 73: 225–231. https://www.jstor.org/stable/25085973

Ćuk M (2019) Status and temporal dynamics of the flora and vegetation of the Deliblato Sands. PHD Thesis. Faculty of Sciences, University of Novi Sad (Serbia).

Ghisbain G, Rosa P, Bogusch P, Flaminio S, Le Divelec R, Dorchin A, Kasparek M, Kuhlmann M, Litman J, Mignot M, Müller A, Praz C, Radchenko VG, Rasmont P, Risch S, Roberts SPM, Smit J, Wood TJ, Michez D, Reverté S (2023) The new annotated checklist of the wild bees of Europe (Hymenoptera: Anthophila). Zootaxa 5327(1): 1–147. https://doi.org/10.11646/zootaxa.5327.1.1

Józan Z (2011) Checklist of Hungarian Sphecidae and Apidae species (Hymenoptera, Sphecidae and Apidae). Natura Somogyiensis 19: 177–199. https://doi.org/10.24394/NatSom.2011.19.177

Krahner A, Dietzsch AC, Jütte T, Pistorius J, Everaars J (2024) Standardising bee sampling: A systematic review of pan trapping and associated floral surveys. Ecology and Evolution 14(3): e11157. https://doi.org/10.1002/ece3.11157

Kuhlman MP, Burrows S, Mummey DL, Ramsey PW, Hahn PG (2021) Relative bee abundance varies by collection method and flowering richness: Implications for understanding patterns in bee community data. Ecological Solutions and Evidence 2(2): e12071. https://doi.org/10.1002/2688-8319.12071

Lebedev A (1931) Prilog poznavanju jugoslovenskih pčela. Glasnik Jugoslovenskog entomološkog društva, Beograd, Jugoslavija 5–6(1–2): 39–48.

Leclercq N, Marshall L, Weekers T, Anselmo A, Benda D, Bevk D, Bogusch P, Cejas D, Drepper B, Galloni M, Gérard M, Ghisbain G, Hutchinson L, Martinet B, Michez D, Molenberg J-M, Nikolic P, Smagghe G, Straka J, Vandamme P, Wood T, Vereecken N (2022) A comparative analysis of crop pollinator survey methods along a climatic gradient. Agriculture, Ecosystems and Environment 329: e107871. https://doi.org/10.1016/j.agee.2022.107871

Michez D, Eardley CD (2007) Monographic revision of the bee genus *Melitta* Kirby, 1802 (Hymenoptera: Apoidea: Melittidae). Annales de la Société Entomologique de France (n. s.) 43(4): 379–440. https://doi.org/10.1080/00379271.2007.10697535

Michez D, Nieto A (2012) *Melitta melanura* (Europe assessment). The IUCN Red List of Threatened Species 2012: e.T13324607A13324761. https://www.iucnredlist.org/species/13324607/13324761#assessment-information [Accessed on 18.06.2024]

Michez D, Patiny S, Rasmont P, Timmermann K, Vereecken NJ (2008) Phylogeny and host-plant evolution in Melittidae s.l. (Hymenoptera: Apoidea). Apidologie 39: 146–162. https://doi.org/10.1051/apido:2007048

Mudri-Stojnić S, Andrić A, Markov-Ristić Z, Đukić A, Vujić A (2021) Contribution to the knowledge of the bee fauna (Hymenoptera, Apoidea, Anthophila) in Serbia. ZooKeys 1053: 43–105. https://doi.org/10.3897/zookeys.1053.67288

Mudri-Stojnić S, Andrić A, Józan Z, Likov L, Tot T, Grković A, Vujić A (2023) New records for the wild bee fauna (Hymenoptera, Anthophila) of Serbia. Journal of Hymenoptera Research 96: 761–781. https://doi.org/10.3897/jhr.96.107595

Nielsen A, Steffan-Dewenter I, Westphal C, Messinger O, Potts SG, Roberts SPM, Settele J, Szentgyörgyi H, Vaissière BE, Vaitis M, Woyciechowski M, Bazos I, Biesmeijer JC, Bommarco R, Kunin WE, Tscheulin T, Lamborn E, Petanidou T (2011) Assessing bee species richness in two Mediterranean communities: importance of habitat type and sampling techniques. Ecological Research 26(5): 969–983. https://doi.org/10.1007/s11284-011-0852-1

Nieto A, Roberts SPM, Kemp J, Rasmont P, Kuhlmann M, García Criado M, Biesmeijer JC, Bogusch P, Dathe HH, De la Rúa P, De Meulemeester T, Dehon M, Dewulf A, Ortiz-Sánchez FJ, Lhomme P, Pauly A, Potts SG, Praz C, Quaranta M, Radchenko VG, Scheuchl E, Smit J, Straka J, Terzo M, Tomozii B, Window J, Michez D (2014) European Red List of Bees. Publications Office of the European Union (Luxembourg): 1–84. https://doi.org/10.2779/77003

Official Gazette RS (2016) Rulebook on declaration and protection of strictly protected and protected wild species of plants, animals and fungi. Official Gazette of Republic of Serbia No. 05/10, 47/11, 32/16 and 98/16. https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/eli/rep/sgrs/ministarstva/pravilnik/2010/5/3/reg [Accessed on 20.06.2024]

Official Gazette RS (2020) Spatial Plan Republic of Serbia 2021–2035. Official Gazette of Republic of Serbia No. 48/19. https://media1.opstinamalocrnice.rs/2020/03/PROSTORNI-PLAN-REPUBLIKE-SRBIJE-OD-2021.-DO-2035.GODINE.pdf [Accessed on 20.06.2024]

Özbek H (2014) Distribution data on the family Melittidae (Hymenoptera) of Turkey with considerations about their importance as pollinators. Turkish Journal of Zoology 38(4): 444–459. https://doi.org/10.3906/zoo-1309-5

Potts S, Dauber J, Hochkirch A, Oteman B, Roy D, Ahnre K, Biesmeijer JC, Breeze T, Carvell C, Ferreira C, Fitzpatrick Ú, Isaac N, Kuussaari M, Ljubomirov T, Maes J, Ngo H, Pardo A, Polce C, Quaranta M, Settele J, Sorg M, Stefancesu C, Vujić A (2021) Proposal for an EU pollinator monitoring scheme. Publications Office of the European Union (Ispra), 1–310. https://doi.org/10.2760/881843

Radchenko V (2009) *Melitta* (*Cilissa*) *wankowiczi* (Radoszkowski, 1891). In: Akimov IA (Ed.) Red Data Book of Ukraine - Animal Kingdom. Global consulting (Kiev), 252–252.

Reverté S, Miličić M, Ačanski J, Andrić A, Aracil A, Aubert M, Balzan MV, Bartomeus I, Bogusch P, Bosch J, Budrys E, Cantú-Salazar L, Castro S, Cornalba M, Demeter I, Devalez J, Dorchin A, Dufrêne E, Đorđević A, Fisler L, Fitzpatrick Ú, Flaminio S, Földesi R, Gaspar H, Genoud D, Geslin B, Ghisbain G, Gilbert F, Gogala A, Grković A, Heimburg H, Herrera-Mesías F, Jacobs M, Milosavljević MJ, Janssen K, Jensen J-K, Ješovnik A, Józan Z, Karlis G, Kasparek M, Kovács-Hostyánszki A, Kuhlmann M, Le Divelec R, Leclercq N, Likov L, Litman J, Ljubomirov T, Madsen HB, Marshall L, Mazánek L, Milić D, Mignot M, Mudri-Stojnić S, Müller A, Nedeljković Z, Nikolić P, Ødegaard F, Patiny S, Paukkunen J, Pennards G, Pérez-Bañón C, Perrard A, Petanidou T, Pettersson LB, Popov G, Popov S, Praz C, Prokhorov A, Quaranta M, Radchenko VG, Radenković S, Rasmont P, Rasmussen C, Reemer M, Ricarte A, Risch S, Roberts SPM, Rojo S, Ropars L, Rosa P, Ruiz C, Sentil A, Shparyk V, Smit J, Sommaggio D, Soon V, Ssymank A, Ståhls G, Stavrinides M, Straka J, Tarlap P, Terzo M, Tomozii B, Tot T, van der Ent L-J, van Steenis J, van Steenis W, Varnava AI, Vereecken NJ, Veselić S, Vesnić A, Weigand A, Wisniowski B, Wood TJ, Zimmermann D, Michez D, Vujić A (2023) National records of 3000 European bee and hoverfly species: A contribution to pollinator conservation. Insect Conservation and Diversity 16: 758–775. https://doi.org/10.1111/icad.12680

Roulston TH, Smith SA, Brewster AL (2007) A comparison of pan trap and intensive net sampling techniques for documenting a bee (Hymenoptera: Apiformes) fauna. Journal of the Kansas Entomological Society 80(2): 179–181. https://doi.org/10.2317/0022-8567(2007)80[179:ACOPTA]2.0.CO;2

SPAS (2022–2024) Serbian Pollinator Advice Strategy - for the next normal. Science Fund of the Republic of Serbia, Program IDEAS, GA ID: 7737504. https://spas.pmf.uns.ac.rs/en/ [Accessed on 01.07.2024]

Tomozii B (2010) Bees of Romania. https://www.beesofromania.ro/home [Accessed on 01.07.2024]

Vorgin V (1918) Pregled Apidae hrvatske Slavonije i hrvatskog Primorja s obzirom na faunu Apida Dalmacije. Glasnik Hrvatskoga prirodoslovnoga društva, Zagreb 30: 1–4.

Westphal C, Bommarco R, Carré G, Lamborn E, Morison N, Petanidou T, Potts SG, Roberts SPM, Szentgyörgyi H, Tscheulin T, Vaissière BE, Woyciechowski M, Biesmeijer JC, Kunin WE, Settele J, Steffan-Dewenter I (2008) Measuring bee diversity in different European habitats and biogeographical regions. Ecological Monographs 78(4): 653–671. https://doi.org/10.1890/07-1292.1

Supplementary material 1

The list of all bee species recorded during the surveys of selected sites in 2023

Authors: Sonja Mudri-Stojnić, Andrijana Andrić, Laura Likov, Ana Grković, Tamara Tot, Ivana Kavgić, Ante Vujić

Data type: xlsx

Explanation note: The list of all recorded bee species with additional information: IUCN categories; collection methodology types; records new for Serbia; records previously based only on literature data.

Copyright notice: This dataset is made available under the Open Database License (http://opendatacommons.org/licenses/odbl/1.0/). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.

Link: https://doi.org/10.3897/jhr.97.134513.suppl1

Supplementary material 2

The list of specimens of bee species with data previously available only from sources prior to year 2000

Authors: Sonja Mudri-Stojnić, Andrijana Andrić, Laura Likov, Ana Grković, Tamara Tot, Ivana Kavgić, Ante Vujić

Data type: xlsx

Explanation note: Detailed information on collected specimens of bee species with data previously available only from sources prior to year 2000: locality, date, sex, identification code, collection methodology, legator.

Copyright notice: This dataset is made available under the Open Database License (http://opendatacommons.org/licenses/odbl/1.0/). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.

Link: https://doi.org/10.3897/jhr.97.134513.suppl2

Supplementary material 3

The list of specimens of bee species reported as new records in the previous update of Serbian bee fauna

Authors: Sonja Mudri-Stojnić, Andrijana Andrić, Laura Likov, Ana Grković, Tamara Tot, Ivana Kavgić, Ante Vujić

Data type: xlsx

Explanation note: Detailed information on collected specimens of bee species reported as new records in the previous update of Serbian bee fauna: locality, date, sex, identification code, collection methodology, legator.

Copyright notice: This dataset is made available under the Open Database License (http://opendatacommons.org/licenses/odbl/1.0/). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.

Link: https://doi.org/10.3897/jhr.97.134513.suppl3